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Diversity of Vertebrates in Wildlife Water-Impoundments on the Chippewa National Forest

John R. Probst, Donald Rakstad, and Kathy Brosdahl

North Central Forest Experiment Station
Forest Service—U.S. Department of Agriculture
1992 Folwell Avenue
St. Paul, Minnesota 55108
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DIVERSITY OF VERTEBRATES IN WILDLIFE WATER-IMPOUNDMENTS ON THE CHIPPEWA NATIONAL FOREST

John R. Probst, *Research Biologist,*
Donald Rakstad, *Biological Technician,*
and **Kathy Brosdahl,** *Biological Aid*

Wetlands cover 154,000 acres of the Chippewa National Forest, or 24 percent of its surface area. In 1965, only about one-fourth of this area was at or near its full potential for waterfowl production (Mathisen 1965). The management plan called for improving about 50,000 acres of the sub-optimum wetland by burning, blasting, and constructing artificial impoundments and nesting sites.

Since that time, 47 low-head dams have been constructed to flood the less productive sedge meadows and shrub swamps to create habitats more attractive to most species of wildlife in the area. Most of these structures reclaim abandoned beaver flowages as well. In addition, more than 5,000 potholes have been excavated and more than 7,000 nesting structures have been placed in the Chippewa's wetlands.

Artificial impoundments facilitate manipulation of water levels, allowing for the maintenance of open water in places that had been choked with too much vegetation for optimum wildlife use. Water levels can also be lowered periodically to permit the oxidation of plant nutrients trapped in the sediments, to prevent drowning of desirable shrubs, and to stimulate the growth of emergent vegetation. The subsequent controlled reflooding retards hydric succession, maintains the emergent vegetation, and allows aquatic animals to utilize the new vegetative growth.

Our study assesses the response of vertebrates to the establishment of low-head dams constructed to flood less productive sedge meadows and shrub swamps. We did this by compiling lists of species using these artificial wetlands and comparing them with lists from known habitats and range, and those found in unmanaged wetlands.

Kirby (1975) listed the species of vertebrates he saw or found evidence of on beaver flowages in the Chippewa National Forest. His list, which included 37 mammals, 129 birds, 4 reptiles and 7 amphibians, provides a baseline for comparison with our results from water impoundments. In addition, there is some earlier information on avian use of the Chippewa impoundments (Mathisen *et al.* 1974).

While the primary objective of impounding wetlands is to increase waterfowl production, these habitats are attractive to other wildlife as well. They are important habitat for some sensitive or endangered species such as the bald eagles and ospreys, and they can support a variety of furbearing mammals and several important fish species, such as northern pike. Obviously, developed wetlands have high potential for recreational activities such as hunting, fishing, ricing and birding.

Edge habitats and patchy vegetation often support higher numbers of species and individuals than more homogeneous cover; this is particularly true of bird species. At least 30 of the land birds listed in the studies cited above almost certainly would not be present outside of marsh or edge habitat. Others would still be found in the surrounding woodland, but probably in lower densities.

This study assesses the value of impounded wetlands for wetland species, other wildlife that use the impoundments opportunistically, and for valuable or threatened species in particular. The benefits to wildlife of impoundments relative to unimproved wetlands are evaluated. The results presented permit preliminary predictions about the effects on wildlife of impoundment management and tentative recommendations concerning future impoundment sites.

METHODS

Studies were conducted on and adjacent to 11 impoundments containing various habitat types. Wildlife observations were made for 2 consecutive years (1978-1979) on nine of the impoundments, and for 1 year on the two remaining impoundments. Observations were made primarily from May through mid-October, with limited visits during the winter to record animal tracks and wintering birds. Observation periods lasted about 3 hours each, primarily in the early morning and late afternoon.

Observations were made at least once and usually twice a week at every impoundment. Platforms were constructed 10 to 14 m above ground in prominent trees along the edges of the impoundments, at points where the greatest portions of the impoundments were visible. Some observations were obtained while walking the perimeters.

Terrestrial birds within 100 feet of the impoundments were counted using sight, sound, and nest observations. They were then assigned to relative abundance categories and classified as being resident, breeding, migrant, or visitor. The same data were obtained for water birds. Mammals in and adjacent to the impoundments were recorded using sightings, tracks, scats, and other signs. Small mammals were trapped in selected edge or drawdown habitats in August of 1978, and in emergent drawdown habitat in August of 1979. Snap traps were positioned in pairs on a 8- x 17-m grid. Herptofauna were noted by sight and sound.

The following eight basic habitat types were recognized:

Water.—Almost all of the wetland vegetation and edges were interspersed with standing water for at least part of the year. We recognized large patches of open water not well mixed with other vegetation life forms as a separate type. In these shallow wetlands, most open water areas covered submerged aquatic vegetation.

Emergents.—Most emergent vegetation was flooded to 70 cm of water for much of the warm season. This type included broad-leafed emergents such as cattails (*Typha* spp.) and narrow-leafed emergents such as sedges, rushes, and grasses. Emergents were often interspersed with floating aquatic plants. This type often spatially overlapped other types such as dead timber, wetland shrubs, and seasonally flooded woodlands.

Wetland Shrubs.—Seasonally flooded shrubs, chiefly willow (*Salix* spp.) and speckled alder (*Alnus rugosa),* were distinguished from the under-story of the forests surrounding the impoundments. The wet substrate beneath these shrubs was often covered by herbaceous vegetation. The wetland shrubs that were permanently inundated were often in poor condition or dead.

Dead Timber.—The construction of low-head dams flooded portions of the surrounding forest. The resultant patches of dead trees created important habitat for cavity-nesting mammals and birds.

Deciduous Forest.—Broad-leafed forest was the most common edge type around the impoundments (55 percent of the Chippewa National Forest is typed aspen-birch, and 15 percent is northern hardwoods) (Kirby 1975). In addition to trembling aspen (*Populus tremuloides),* balsam poplar (*P. balsamifera),* paper birch (*Betula papyrifera)* and bur oak (*Quercus macrocarpa),* the deciduous forests contained scattered red pine (*Pinus resinosa)* and white pine (*P. strobus).* The most common northern hardwood trees were sugar maple (*Acer saccharum),* green ash (*Fraxinus pennsylvanica),* yellow birch (*Betula alleghaniensis)* and red maple (*A. rubrum).*

Mixed Coniferous-broadleaf Forest.—Forest edges that were dominated by conifers or coniferous-broadleaf mixes formed the other forest edge type. The lowland conifer stands were composed of black spruce (*Picea mariana),* tamarack (*Larix laricina),* and northern white-cedar (*Thuja occidentalis).* The upland conifer stands were dominated by white pine and red pine, with scattered paper birch. Balsam fir (*Abies balsamifera)* was often mixed with green ash or aspen.

Ground/Mud.—Exposed mudflats, herbaceous fields, or snow cover surrounding the impoundments were in this category.

Aerial.—Because some species were only recorded in the air over the impoundments, we included this category.

RESULTS

The species recorded in four vertebrate classes were distributed as follows (Appendix I): 38 mammals, 147 birds, 4 reptiles, and 10 amphibians. The cumulative list—ours plus those of Mathisen *et al.* (1974)

and Kirby (1975)—is: 44 mammals, 167 birds, and 14 reptiles and amphibians. These species represent a considerable proportion of the vertebrate fauna found on the Forest as a whole. Of 308 vertebrate species listed on the Chippewa National Forest, (Mathisen 1980), 215 (70 percent) have been found in beaver flowages or water impoundments (77 percent of the mammals, 68 percent of the birds, 57 percent of the reptiles and 77 percent of the amphibians). The results are discussed below by vertebrate group (Appendix I) and habitat group (Appendix II).

Vertebrate Groups

Mammals

Mammalian species included 5 insectivores, 1 chiropteran, 12 carnivores, 16 rodents, 2 lagomorphs, and 2 ruminants. In addition, Kirby (1975) recorded the starnose mole, little brown myotis, least weasel, lynx, plains pocket gopher, and southern bog lemming on natural beaver flowages. Species we recorded in the impoundments that were not in the natural beaver flowages were the Arctic shrew, fisher, Franklin's ground squirrel, gray squirrel, eastern cottontail and moose. Most mammals were found at two or more impoundments and are probably well distributed. Some are nocturnal or secretive and may be more common than indicated in Appendix I. Others are more likely transients because suitable habitat is not commonly found in the impoundments (such as the Arctic shrews and ground squirrel) or because they are at the border of their ranges (such as the gray squirrel). It is unlikely that any of the mammals were found only in the artificial or only in the natural wetlands because of specific habitat preferences. Instead, the lists may be incomplete because of the chance element involved in recording rare or secretive animals. Individual impoundments had from 4 to 22 mammal species recorded, with an average of 12.1. In general, more species were found in the larger, more diverse impoundments.

Birds

One hundred forty-seven bird species were recorded in the impoundments, with a range of 60-106 and an average of 85 species per impoundment. As with the mammals, some species were found only in the artificial or only in the natural wetlands. This can be attributed to factors such as extent of observer coverage, season, or the presence of particular subhabitats. One exception is the greater diversity and number of migrant shorebirds found in the impoundments, due to the mudflats exposed during drawdown. Other wetland birds found only in impoundments included the short-billed marsh wren, northern waterthrush, Caspian tern, and common tern, but the latter two species were rare migrants. It seems likely that the short-billed marsh wren would be found in many natural wetlands. The other 13 birds not recorded in the beaver flowages were found at the edges of the impoundments; at least four of these were at the border of their geographic range (house wren, yellow-billed cuckoo, indigo bunting, hoary redpoll). The hoary redpoll and two shrike species were uncommon and mourning doves and bobolinks do not have appropriate habitat even at the edges of wetlands.

Of the birds that Kirby recorded in the beaver flowages but that were not found in our study or that of Mathisen *et al.*, the least bittern (which is difficult to glimpse or hear) is the only wetland species. The screech owl could probably be found at the edges of the impoundments. The white-winged crossbill is a visitor. Because typical habitat is lacking for the rufous-sided towhee, Savannah sparrow, vesper sparrow, and tree sparrow, sightings of these species would be a chance occurrence in any wetland.

Most bird species listed were recorded at the edges and also would be found away from wetland habitats. Some species are found only in wetland habitats. Other species are intermediate to the above, but their abundance is enhanced through opportunistic use of the impoundments.

The impoundments were attractive to a variety of water birds, including the common loons, pied-billed grebe, great blue heron, and American bittern. The most abundant ducks in the impoundments were the mallard, wood duck, ring-necked duck, and blue-winged teal. Birds of prey, such as the red-tailed hawk, American kestrel, osprey, and bald eagle, hunted in the impoundments and used snags and dead timber as perch sites. The sora and Virginia rails were seen and heard in emergent vegetation. The killdeer and spotted sandpiper were found at the water margins, and other migrant shorebirds used the mudflats exposed during drawdowns. Black terns nested in a few impoundments and belted kingfishers hunted over the open water.

Brown creepers, two species of nuthatches, and five species of breeding woodpecker were found principally in the dead timber. Flycatchers and swallows were attracted to the open nature of the impoundments, and three of the five swallow species were

found at a majority of the impoundments. Both species of marsh wren were present in the emergents. Parids, thrushes, vireos, and tanagers were mostly confined to the upland edges. Common yellowthroats and yellow warblers were regular breeders in the wetland shrubs. Grackles used the water margins regularly, and redwinged blackbirds were abundant in the wetland vegetation. The swamp sparrow and song sparrow were the two most common finches associated with the impoundments.

Reptiles and Amphibians

Northern Minnesota has a depauperate herptofauna, and only 4 reptiles and 10 amphibians were found in the impoundments: two snakes, two turtles, two salamanders and eight anurans.

Individual impoundments supported 1 to 11 species, with an average of 4.9. The species found in a majority of the study areas were the western painted turtle, eastern garter snake, American toad, and northern leopard frog. The mink frog, wood frog, and eastern tiger salamander were near the border of their ranges and were not expected to be particularly abundant. Three species (blue-spotted salamander, wood frog, and green frog) not recorded by Kirby (1975) were found in less than half of the impoundments. The Chippewa National Forest is just north and west of many common, well-distributed species of amphibians and reptiles such as the wood turtle, map turtle, brown snake, northern water snake, bull snake, fox snake, eastern milk snake, bullfrog, and pickerel frog. As a result, the list of herptofauna is not as extensive as it would be in some other parts of the Lake States.

Impoundment Habitats

It is difficult to assess the influence of a given habitat type on an individual species or group of animals, since many species will use more than one habitat type, yet not be observed or trapped in all of them. Although some species may be present because of the proximity of a dissimilar habitat, others are found exclusively in one habitat type, or use some types more than others. Those species frequently showing up in more than one habitat type often did so because of the similarity of the types or interspersion of those types. For example, some mammals and birds were often found in both deciduous and mixed coniferous-deciduous forests, and feeding birds (aerial) often used dead timber for perch sites. Most waterfowl species used open water, dead timber, wetland shrubs, and emergents because of heavy interspersion of these types. Woodpeckers were found in both dead timber and the two forest categories. Appendix II lists the mammal and bird species found in each habitat type, and table 1 summarizes the numbers of species listed for each habitat type.

Open Water

The open water areas were used by eight mammalian species including muskrat, beaver, moose, mink and river otter. The principal avian users of open water were waterfowl, including 12 species of ducks. The common loon, osprey, American coot, and migrant terns used this habitat type exclusively.

Emergents

Eleven mammals were recorded in the emergent vegetation. In addition to those species found also in the open water, five small mammals were trapped in this type during a drawdown (three species of shrews, meadow vole, meadow jumping mouse). Emergents were used by 21 bird species, including most of the ducks in the open water, as well as the American bittern, black tern, and sora and Virginia rails. This habitat was also important to several passerine birds, including the swamp sparrow, eastern kingbird, redwinged blackbird, long-billed marsh wren and short-billed marsh wren. The latter two species, which depended on emergent vegetation as their chief habitat, were found in broad-leafed and narrow-leafed emergents, respectively.

Wetland Shrubs

The eight mammalian species observed in the shrub type were beaver, black bear, masked shrew, meadow vole, deer mouse, white-footed mouse, meadow jumping mouse, and the woodland jumping mouse (the latter was trapped only in this habitat). The common birds in the wetland shrub were the swamp sparrow, eastern kingbird, common yellowthroat and alder flycatcher. A number of the dabbling ducks and their broods used this type extensively. Most of the mammals and land birds in this habitat probably occur at similar densities in undeveloped wetlands.

Aerial

One group of animals did much or all of their foraging in the air, either capturing insects or sighting prey in or around the water from the air. The only bat sighted was the big brown bat. Aerial foragers most frequently sighted included the black tern, common nighthawk, chimney swift, cedar waxwing, osprey, bald eagle, five species of swallows, several species of hawks, and the four corvids. Snipe were

observed performing aerial courtship displays over the impoundments. Thirteen of the 31 bird species were recorded only in the air. The insectivorous and piscivorous birds are probably more common near impoundments than in undeveloped wetlands because of more open water in the impoundments.

Dead Timber

The few mammals recorded in this type (table 1 and Appendix II) included seven small mammal species trapped during a drawdown: two shrews, two voles, two squirrels, and the meadow jumping mouse. Eight of the 44 bird species found in the dead timber areas were not recorded outside those areas, including the green heron, both shrikes, the red-headed woodpecker, and the tree swallow. The swallows were attracted by opportunities for nest cavities in the dead timber as were several other bird species. The shrikes, the belted kingfisher, and the flycatchers found perch sites on the snags. Birds reaching peak abundance in this habitat were the cedar waxwing, common grackle, and goldfinch. Bark foragers such as the woodpeckers, the nuthatches and the brown creeper may find abundant prey in the decaying wood.

Deciduous Forest

Deciduous forest and coniferous-broadleaf forest are abundant in the Chippewa National Forest, but are not wetland habitats. However, they form the major edge habitat in both artificial and natural wetlands, and many wetland species use the upland for important aspects of their life cycles such as nesting or cover. The two forest edges supported 19 mammalian species, but only seven of these were in the deciduous habitat. The gray squirrel was seen only in this habitat, while the fisher is rare throughout the Chippewa National Forest. Seventy-two bird species were observed in the forest edges, 37 of them exclusively. The 54 birds in the deciduous type represented the highest species count for any of the habitats (table 1). Nine avian species were found only in the deciduous forest, including the barred owl, yellow-billed cuckoo, house wren, wood thrush, three of the four vireos, and two of the 10 warblers. Most other families of land birds were also well represented in this habitat (Appendix II).

Mixed Forest

The mixed coniferous-broadleaf forest habitat type had 15 mammalian species, including seven small mammals. One of these, the northern flying squirrel, was trapped only in this type. Other species noted by sight or sign included the red squirrel, eastern chipmunk, porcupine, snowshoe hare, moose, white-tailed deer, and black bear. Forty-four bird species were recorded in the mixed forest, 15 of them exclusively. Exclusive species included the goshawk, gray jay, winter wren, Swainson's thrush, ruby-crowned kinglet, solitary vireo, and 6 of the 11 warblers.

Table 1.—*Bird and mammal species recorded by habitat type for 11 impoundments on the Chippewa National Forest (parentheses indicate the number of species found only in that type)*

Habitat type	Species	
	Mammals	Birds
	Number	
Water	8	18 (5)
Emergents	11	21 (4)
Wetland shrubs	8 (1)	32 (8)
Dead timber	12	44 (8)
Aerial	1	31 (13)
Deciduous forest	7 (1)	54 (9)
Mixed forest	15	44 (15)
Ground/mud	29 (11)	16 (11)

Ground/Mud

Twenty-nine mammals were recorded by sight, tracks, or trapping in impoundment edges such as fields, trails, snow-covered ice or seasonally dry sedge marsh. The following 11 species were found exclusively in these open areas, primarily detected by tracks in mud and snow: the Arctic shrew, both weasels, striped skunk, coyote, red fox, gray wolf, bobcat, two ground squirrels, and the eastern cottontail. There were signs or sightings of mink, river otter, moose, black bear, and fisher. Six birds of open areas were found in the grassy areas, and four of them (fox sparrow, dark-eyed junco, and both redpolls) were found exclusively in the open edges. The American woodcock was flushed from some field edges.

The mud margins and mudflats exposed by drawdowns were used by breeding killdeer, common snipe, and spotted sandpipers. The mudflats received substantial use by migrant shorebirds, such as solitary sandpipers, lesser and greater yellowlegs, least sandpipers, and pectoral sandpipers. While muddy margins around lakeshores and natural wetlands are common in the Chippewa National Forest, extensive mudflats are scarce, and this habitat may be the most unusual one created by artificial impoundments.

SUMMARY OF RESULTS

1. The species list of vertebrates recorded in the artificial water impoundments is remarkably similar to the list for natural beaver flowages. Most differences that do exist are almost certainly due to chance events rather than substantive habitat differences, especially for migrant birds and rare animals at their range borders. The major habitat difference that does exist between these two types of wetland is the presence of extensive mudflats that result from the scheduled drawdowns in the impoundments. These mudflats are particularly beneficial for shorebirds.
2. Impounded wetlands are valuable habitat for game species such as black bear, moose, white-tailed deer, waterfowl, rails, common snipe and American woodcock. In addition, these areas are used by furbearers such as red fox, muskrat, beaver, and some mustelids.
3. The wetlands can be important to endangered, threatened or sensitive species such as the fisher, timber wolf, common loon, bald eagle, and osprey.
4. a. The impoundments also maintain or enhance populations of wetland mammals such as the northern water shrew, river otter, and mink.
   b. Wetland bird species utilizing these impoundments include five waders, 15 waterfowl, three raptors (marsh hawk, bald eagle, osprey), two rails, eight shorebirds, three terns, the belted kingfisher, and two marsh wrens.
   c. Most of the reptiles and amphibians on the Chippewa are associated with wetland habitats, including the two turtles, two salamanders, and all eight anurans recorded in this study.
5. Still other vertebrate species should have higher populations because of the increased edge, interspersion, productivity, nest cavities, or perch sites present in these improved wetlands. Species enhanced are the eastern garter snake, masked shrew, short-tailed shrew, raccoon, at least two mustelids, and the meadow jumping mouse. Raptors using the impoundments opportunistically include the American kestrel, red-tailed hawk and broad-winged hawk. These wetland habitats also provide openings and abundant prey for insectivorous aerial foragers such as bats, the common nighthawk, the chimney swift and several swallow species. The dead timber provides nest cavities for the common goldeneye, hooded merganser, wood duck and American kestrel, as well as for several mammals and passerine birds. The flooded timber and snags are a foraging substrate for five woodpeckers, two nuthatches, and the brown creeper, and they provide perches for insectivorous hawkers (including four flycatchers, one woodpecker, and the cedar waxwing). Habitat is also maintained for several warblers and four species of sparrows that occupy hydric successional stages.

DISCUSSION

It is difficult to compare the results of this study with those conducted in other places in the Lake States, because of differences in habitat and geographic ranges of species. The study of Chippewa National Forest beaver flowages (Kirby 1975) is the most similar to the present study. Despite minor differences in methodology and observer coverage, the results are strikingly similar. We now need additional comparisons between impoundments and analogous undeveloped wetlands such as sedge meadows and shrub swamps.

One such study from southern Minnesota (Biebighauser 1979) reported the vertebrate inventories of two impoundment sites before flooding. Both sites had areas of wetland shrub and deciduous forest that were surveyed for vertebrate species composition. The list of reptiles and amphibians was similar to that of the Chippewa wetlands (within the limits of geographic ranges), but fewer mammal and bird species were recorded. This was not unexpected, however, because of the smaller area of wetland surveyed, the fragmentation of forest in southern Minnesota, and the distance from the boreal forest transition zone to the north. The impoundments were projected to be beneficial to wildlife because of stabilized water levels, more open water, additional edge, and greater interspersion and diversity of vegetation.

A vertebrate survey of the Sturgeon River Wilderness Area in the Upper Peninsula of Michigan (Crider 1979) included a larger proportion of upland habitat than our study. Nevertheless, the list of herptofauna totaled 13 species (11 in water and wetlands), similar to the 14 in our study. The proportion of reptiles relative to amphibians was higher in the Sturgeon River study, however. The mammal list from the Sturgeon River was somewhat smaller (29) than from the Chippewa (38), but three additional bat species were recorded. Only 100 bird species were listed, compared with our 147, a difference probably attributable to the more homogeneous upland habitat surveyed.

Another study in the Upper Peninsula McCormick Forest (Robinson and Werner 1975) listed 33 mammals out of an estimated possible 45 species, and 109

bird species out of 200-plus that could occur in that area. The McCormick Forest survey also covered a larger proportion of upland habitat than did our Chippewa Forest study. Eleven amphibians were found (four salamanders and seven anurans), compared with 10 in the Chippewa Forest wetlands. Five reptiles were listed in the McCormick Forest, including one snake not found in northern Minnesota. Robinson and Werner also estimated the biomass of amphibians in four habitats. They found that the upland forest supported an amphibian biomass an order of magnitude lower than those of three aquatic habitats. Among the aquatic study areas, bogs had twice the amphibian biomass of ponds, and over three times that of streams.

The Attraction of Wetlands to Wildlife

A number of factors cause wetlands to attract and support a high density and diversity of vertebrate species. One attraction is the water itself, which is directly responsible for the presence of 10 to 12 amphibians in most areas of the northern Lake States. Sources of drinking water can be important to many mammals. Open water holds a direct source of food for many vertebrates in the form of fish and aquatic insects. The openings above or adjacent to the open water allow additional species to harvest such resources. Kirby (1975) estimated that 4 mammals, 22 birds and 6 amphibians and reptiles would not have been present in the beaver flowages without the presence of open water. Most wetlands also produce an abundance of small seeds which are an important food source for birds and smaller mammals (Reese and Hair 1976). The high net primary productivity of wetlands supports the entire aquatic food chain. Flowages and impoundments with fluctuating water levels tend to retard hydric succession and maintain vegetation in younger stages of higher net productivity. Flooding also increases the perimeter and thus the amount of edge of the wetland and the interspersion among types. Where forest patches are killed by permanent or temporary flooding, dead trees provide animal dens and sites for cavity nesters.

Many bird species respond directly to the higher food availability discussed above. Other birds are attracted to the patterns of vegetation around the impoundments by more indirect mechanisms. For example, avian diversity is strongly related to the vertical complexity of foliage and number of vegetative life forms (MacArthur and MacArthur 1961, Willson 1974, Probst 1979). Horizontal complexity or patchiness adds habitat structure that can also increase avian diversity (MacArthur 1964, Roth 1976). Because water attracts bird species both directly and indirectly (Karr 1968), avian diversity increases on a gradient from simple upland forests to bottomland forests to beaver ponds (Reese and Hair 1976). Shorebirds can often benefit from water developments targeted for other objectives, such as flood control, reservoirs, municipal water supplies, and stock-watering ponds (Evans and Kerbs 1977). Because the mudflats that result from the impoundment drawdowns attract migrant shorebirds, drawdown schedules should accommodate the peak migration period in late August whenever possible.

Waterfowl benefits are a prime reason for wetland development, and impoundments can be as useful for waterfowl as natural wetlands (Brumsted and Hewitt 1952). The Chippewa impoundments support 32 to 68 pairs of nesting ducks each spring (Mathisen *et al.* 1974). Waterfowl production of managed wetlands in the forested areas of the Lake States compares favorably with some prairie marshes, especially during drought years (Hawkins and Green 1966). Without drawdowns, older impoundments become less attractive to ducks (Kadlec 1962, Nevers 1968).

Mammalian species also benefit from the productivity and habitat complexity of impounded wetlands. Small mammals are attracted to the margins, and some rodents, such as muskrat, utilize the emergents. The carnivores are drawn to the productive aquatic food chains, as well as to terrestrial animals that use wetlands for feeding or drinking. Several species, including the raccoon, mink, river otter, and beaver, center most of their activities on water.

Vertebrate Diversity and Relative Value of Habitat Types

To provide the best possible wildlife habitat in these impoundments, land managers should strive to select sites that will provide significant amounts of wetland shrubs, open water, emergent vegetation, and flooded dead timber. It is necessary to maintain some openings as field and shrubland adjacent to impoundments for maximum vertebrate diversity. Some sites should be managed for specific habitats or a restricted range of species, since it is not always possible to provide optimal habitat for all species. This is especially true for smaller impoundments. For example, small wetlands with a high proportion of flooded timber could be oriented toward wood ducks.

The two forest edges in our study supported 72 bird species, 37 of which were not found in any other habitats. While more bird species were recorded in the deciduous forest edge than in the mixed forest edge, the latter held more unique species and over twice as many mammal species (table 1). However, these forest edge types are abundant throughout the Chippewa National Forest and are not a major concern for impoundment management. The large areas of water created by the impoundments were of prime benefit to waterfowl, especially diving ducks. Open water is also of particular use to ospreys and belted kingfishers. Based on our experience at the East Lake Impoundment, two hectares of open water should be enough to attract waterfowl preferring that habitat.

The majority of the aerial foraging birds and bats could be found in most openings in both wetland and upland habitat. All bird and mammal species found in the open water were also recorded in the emergent vegetation, but additional species were found there; it is especially important to ducks, American bitterns, marsh wrens, and swamp sparrows. The wetland shrubs enhanced populations of several warblers and many duck species. The flooded timber habitat attracted few mammals, but 44 bird species used this type, including eight unique to that type. The emergents appeared to support the greatest number of wetland species, even though the other two wetland types may have held more unique species or more species that use the impoundments opportunistically.

In our study, most ducks showed some preference for single habitats within the impoundments (Appendix II and Caple 1972). For example, American wigeon and blue-winged teal were most often found in emergents, and open water was the preferred habitat of the common goldeneye, ring-necked duck, and hooded merganser. However, almost all species used a number of habitats for some or all of their breeding cycle.

Artificial structures can be beneficial to waterbirds for nesting, loafing and roosting. Nest boxes on the Chippewa were used by wood ducks, common goldeneyes, and hooded mergansers, and pushup islands and floating sedge mats were used for resting and limited nesting by ducks. The sedge mats were particularly valuable as common loon nest sites, and nest success is probably higher on the mats than at natural sites (Mathisen *et al.* 1974).

RECOMMENDATIONS FOR MANAGERS

1. To provide appropriate habitat for a variety of vertebrate species, managers should select impoundment sites that can produce substantial areas of open water, emergent vegetation, wetland shrubs, and dead timber.

2. To achieve maximum vertebrate diversity, open areas such as fields and shrublands should be maintained in adjacent uplands.

3. It may not be practical to attempt to provide optimum habitat for all species, especially at smaller impoundments. Some sites should be managed for specific habitats and a more restricted range of species.

4. If an impoundment is to be managed for specific target species, it may be important to consider the composition of the surrounding uplands in site selection and subsequent management.

5. Artificial structures such as nest boxes, sedge mats and push-up islands can benefit several vertebrate species.

6. Drawdowns should be scheduled to accommodate peak shorebird migration, if this does not compromise other management objectives.

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APPENDIX I: OCCURRENCE OF IMPOUNDMENT VERTEBRATES MAMMALS 1978 & 1979

Species	Amik (1979) (108A)	Ball Club (49A)	Bear Brook (58A)	Beaver Lodge (77A)	Brush Lake (26A)	Cuba (1978) (29A)	East Lake (15A)	Hanson Lake (94A)	Ketchum (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Masked shrew *Sorex cinereus*			V[1]	V[1]		V[1]		V[1]	V[1]			
Arctic shrew *Sorex arcticus*										V[1]		
N. Water shrew *Sorex palustris*								V		V		V[1]
Pygmy shrew *Microsorex hoyi*									V[1]			V
Short-tailed shrew *Blarina brevicauda*			V[1]			V[1]		V[1]	V[1]	V[1]	V[1]	V[1]
Starnose mole *Condylura cristata*												V[1]
Little brown myotis *Myotis lucifugus*												V[1] +
Big brown bat *Eptesicus fuscus*					V			V				V
Black bear *Ursus americana*	S			V	V/S	V	S	S			S	V+
Raccoon *Procyon lotor*	S		V	S		V		S	V+		V	V+
Fisher *Martes pennanti*				S					V			
Short-tailed weasel *Mustela erminea*				S								V
Least weasel *Mustela rixosa*												V[1]
Long-tailed weasel *Mustela frenata*					V							V
Mink *Mustela vison*				S							V	V
River otter *Lutra canadensis*	V		V	V	V	S		V				V[1]
Striped skunk *Mephitis mephitis*		V		S				S		V		V+
Coyote *Canis latrans*								S		V		V
Wolf *Canis lupus*				S								C
Red fox *Vulpes fulva*			S									V+
Lynx *Lynx canadensis*												V
Bobcat *Lynx rufus*				S								S+
Woodchuck *Marmota monax*					V			V				V+
13-lined ground squirrel *Spermophilus tridecemlineatus*								V				V+
Franklin's ground squirrel *Spermophilus franklini*				V								

(table continued on next page)

(table continued)

Species	Amik (1979) (108A)	Ball Club (49A)	Bear Brook (58A)	Beaver Lodge (77A)	Brush Lake (26A)	Cuba (1978) (29A)	East Lake (15A)	Hanson Lake (94A)	Ketchum (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Eastern chipmunk *Tamias striatus*	V	V	V[1]	V	V	V[1]	V	V	V			V+
Red squirrel *Tamiasciurus hudsonicus*	V		V	V	V	V	V	V	V			V+
Gray squirrel *Sciurus carolinensis*		V										
N. flying squirrel *Glaucomys sabrinus*								V[1]				V[1]+
Plains pocket gopher *Geomys bursarius*												S
Beaver *Castor canadensis*	S	S	V		V				V	V	V	V+
Deer mouse *Peromyscus maniculatus*			V[1]	V[1]		V[1]		V[1]				V[1]
White-footed mouse *Peromyscus leucopus*			V[1]	V[1]		V[1]		V[1]		V[1]		V+
Southern bog lemming *Synaptomys cooperi*												V[1]
Boreal redback vole *Clethrionomys gapperi*						V[1]		V[1]				V[1]+
Meadow vole *Microtus pennsylvanicus*				V[1]		V[1]		V	V	V[1]		V+
Muskrat *Ondatra zibethica*	V		V	V	V		V	V	V	V	V	V+
Meadow jumping mouse *Zapus hudsonicus*			V[1]	V[1]	V[1]	V[1]		V	V[1]			V
Woodland jumping mouse *Napaeozapus insignis*				V[1]								V
Porcupine *Erethizon dorsatum*	S				V						V	V+
Snowshoe hare *Lepus americanus*			V	V+				V			V+	
E. cottontail *Sylvilagus floridanus*		V	V						V			
Moose *Alces alces*				V+			S					
White-tailed deer *Odeocoileus virginianus*	S		V	V	V	V	V	V	V+	V	V	V+

Note: V — visual observation of the animal
V[1] — specimen captured or found dead
S — tracks or scats found
C — no visual observation, call noted
+ — young + /or nest observed

BIRDS 1978 & 1979

Species	Amik* (1979) (108A)	Ball* Club (49A)	Bear Brook (58A)	Beaver* Lodge (77A)	Brush Lake (26A)	Cuba* (1978) (29A)	East* Lake (15A)	Hanson* Lake (94A)	Ketchum* (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Loons	B*	B*		B*			B*	B[1]				
Common loon												
Grebes												
Horned grebe				*								
Pied-billed grebe	B*	B[1]*	B	B[1]*	B	B	B[1]*	B[1]*	*		B[1]	x
Herons and allies												
Great blue heron	B*	B*	B	B*	B[1]	B*	B*	B*	B*	B	B	x
Green heron	*		B	B*					*		B	x
American bittern	B*	*	B	B[1]*			B[1]	B[1]*	B[1]	B[1]	B	x
Least bittern												x
Great egret			M									
Waterfowl												
Canada goose			M			M	M	M				
Mallard	B[1]*	B[1]*	B[1]	B[1]*	B[1]	B[1]*	B*	B[1]*	B[1]*	B[1]	B[1]	x
Black duck							M					x
Pintail		M		M								
Gadwall		M	M	M								
American wigeon	*	B*	B[1]	B*	B				B	B	B	x
Shoveler				*								
Blue-winged teal	B[1]*	B[1]*	B[1]	B[1]*	B[1]	B*	B*	B[1]*	B[1]*	B[1]	B[1]	x
Green-winged teal	B*	B[1]*	B[1]	B[1]*		*	B*	B		B[1]		x
Wood duck	B[1]*	B[1]*	B[1]	B*	B[1]	B[1]*	B[1]*	B[1]*	B[1]*	B[1]	B[1]	x
Ring-necked duck	B[1]*	B[1]	B[1]	B[1]*	B		B[1]*	B*	B[1]	B[1]	B[1]	x
Lesser scaup		*										
Common goldeneye		B	B	B*	B[1]	B[1]*	B[1]*		B[1]*	B[1]	B[1]	x
Bufflehead	*	*		*	M		*					x
Hooded merganser		B*	B[1]	B[1]*	B	B*	B[1]*	B[1]*	B*		B	x
Vultures, hawks, falcons												
Turkey vulture	B*	B	B	B	B	B		B	B	B	B	x
Goshawk				R	R			R			R	x
Cooper's hawk				B					B			x
Sharp-shinned hawk			B		B			B	B	B	B	x
Marsh hawk		*		S				S	S	S		x
Rough-legged hawk												x
Red-tailed hawk	B	B*	B	B			B	B[1]*	B	B	B	x
Broad-winged hawk		B*	B	B	B	B	B*	B	B*	B	B	x
Red-shouldered hawk					B	B				B	B	
Bald eagle	B[1]*	B*	B	B	B		*	B	B*		B	x
Osprey	B*	B*	B	B*	B	B		B	B*	B	B	x
Kestrel	B	B*	B	B*	B[1]	B	B	B	B	B	B	x
Gallinaceous birds												
Ruffed grouse		R[1]*	R	R[1]*		R	R*	R	R	R	R	x
Cranes and allies												
Virginia rail		B[1]						B[1]				x
Sora rail	B	B[1]*	B[1]	B[1]		B		B[1]	B[1]*	B[1]	B[1]	x
American coot		M	M	*					M	M		x
Shorebirds												
Semipalmated plover			M									
Killdeer	B	B		B*	B			B[1]	B*	B	B	x
American woodcock			B	B*				B	B	B		x
Common snipe	B*	B*	B	B[1]				B[1]	B*	B	B	x

(table continued on next page)

(table continued)

Species	Amik* (1979) (108A)	Ball* Club (49A)	Bear Brook (58A)	Beaver* Lodge (77A)	Brush Lake (26A)	Cuba* (1978) (29A)	East* Lake (15A)	Hanson* Lake (94A)	Ketchum* (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Shorebirds, cont.												
Solitary sandpiper	M		M	M	M	*	M	M	M*	M	M	
Spotted sandpiper	B*			B*	B[1]		B[1]*	B[1]	B		B	x
Lesser yellowlegs	M*		M	M*			M		M	M	M	
Pectoral sandpiper				M*						M	M	
Least sandpiper				M								
Greater yellowlegs			M	M					M			
Terns												
Black tern	B*	B*	B	B[1]*	B			B[1]	B	B	B	x
Common tern	*	M										
Caspian tern	*											
Pigeons and doves												
Mourning dove		*							B			
Cuckoos												
Black-billed cuckoo			B	B	B			B	B		B	x
Yellow-billed cuckoo					B							
Owls												
Great horned owl				*		R		R	R			x
Barred owl	*		R	R	R			R			R	x
Screech owl												x
Goatsuckers												
Common nighthawk	B*				B		B	B	B*	B	B	x
Swifts												
Chimney swift					B	B*			B		B	x
Hummingbirds												
Ruby-throated hummingbird	B	B*	B	B*	B	B*	B[1]	B	B*		B	x
Kingfishers												
Belted kingfisher	B*	B[1]*	B[1]	B[1]*	B[1]	B*	B[1]	B[1]*	B[1]*	B	B	x
Woodpeckers												
Common flicker	B*	B*	B[1]	B*	B[1]	B[1]*	B*	B[1]*	B*	B	B	x
Pileated woodpecker		*	R	R	R	R*		R	R*		R	x
Yellow-bellied sapsucker	B*	B*	B	B	B	B*	B*	B*	B*		B	x
Hairy woodpecker	R*	R*	R	R	R	R	R	R	R*	R	R	x
Downy woodpecker	R	R	R	R	R	R	*	R	R			x
Black-backed three-toed woodpecker	*								*			x
Red-headed woodpecker		M	M		M	M			M		M	
Flycatchers												
Eastern kingbird	B[1]*	B[1]*	B[1]	B[1]*	B	B*	B*	B[1]*	B[1]	B[1]	B[1]	
Great-crested flycatcher	B*	B*	B	B*	B[1]	B*	B*	B	B*	B	B	x
Eastern phoebe	B[1]*	B	B	B[1]*	B	B			B		B	x
Alder flycatcher	B	B	B	B	B			B	B	B	B	x
Least flycatcher	*	B[1]*	B	B*	B	B*	B*	B*	B[1]*	B	B	x
Eastern wood pewee	B	B	B	B	B	B*	B	B	B		B	x
Olive-sided flycatcher	B*		B	B	B		B	B		B	B	x
Swallows												
Barn swallow	*		B	B*				B*	B*	B[1]	B	x
Cliff swallow								B	B			x
Rough-winged swallow		B							B		B	x
Tree swallow	B[1]*	B[1]*	B[1]	B[1]*	B[1]	B[1]*	B[1]*	B[1]*	B[1]*	B[1]	B[1]	x
Purple martin	B[1]*	*		B	B	B			B*		B	x

(table continued on next page)

(table continued)

Species	Amik* (1979) (108A)	Ball* Club (49A)	Bear Brook (58A)	Beaver* Lodge (77A)	Brush Lake (26A)	Cuba* (1978) (29A)	East* Lake (15A)	Hanson* Lake (94A)	Ketchum* (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Jays and crows												
Blue jay	R*	R*	R	R	R	R*	R*	R[1]*	R*	R	R	x
Gray jay	R*			R				R		R		x
Common crow	B*	B	B	B	B	B	B	B	B	B	B	x
Common raven			R	R	R	R	R	R	R	R		x
Chickadees												
Black-capped chickadee	R*	R*	R	R*	R	*	R*	R*	R*	R	R	x
Nuthatches and creepers												
White-breasted nuthatch	R	R	R		R	R*	R	R	R*	R	R	x
Red-breasted nuthatch	R*	R	R	R	R		R	R	R		R	x
Brown creeper					B	B		B				x
Wrens												
House wren				B	B			B			B	
Winter wren	B			B	B		B			B	B	x
Short-billed marsh wren			B					B[1]	B[1]	B[1]	B	
Long-billed marsh wren	B	B						*	B[1]*	B[1]	B	x
Mockingbirds and thrashers												
Catbird	B	B*	B[1]	B[1]*	B		*	B[1]*	B*	B[1]	B[1]	x
Brown thrasher				*								
Thrushes												
Robin	B*	B*	B	B*	B	B*	B*	B[1]*	B*	B	B	x
Wood thrush			B						B			x
Hermit thrush	B				B			M		B		x
Swainson's thrush								M				
Veery	B*	B*	B	B*		B*	B*	B[1]*	B*	B	B	x
Kinglets												
Golden-crowned kinglet												x
Ruby-crowned kinglet		M*			M			M	M		M	x
Waxwings												
Cedar waxwing	B*	B*	B	B*	B	B	B*	B*	B*	B	B	x
Shrikes												
Northern shrike				M								
Loggerhead shrike				S						S		
Starlings												
Starling	B*	B*		B			B	B[1]				
Vireos												
Solitary vireo	B		M					M	*			x
Red-eyed vireo -	B*	B[1]*	B[1]	B[1]*	B[1]	B[1]*	B[1]*	B*	B[1]*	B[1]	B[1]	x
Philadelphia vireo									B			
Warbling vireo		B	B	B			B		B	B	B	
Yellow-throated vireo		B	B		B	B					B	x
Warblers												
Magnolia warbler	B			B		B					B	x
Blackpoll warbler	*							*				
Black and white warbler	B*	B	B	B	B		B*	B	B	B	B	x
Tennessee warbler						B	*					x
Nashville warbler	B	B	B	B	B			B	B	B	B	x
Parula warbler	B*	B	B	B*	B		B*	*	B*	B		x
Cape May warbler											M	x
Yellow-rumped warbler	B*	B	M	M	M		M	M	M	M	M	x

(table continued on next page)

(table continued)

Species	Amik* (1979) (108A)	Ball* Club (49A)	Bear Brook (58A)	Beaver* Lodge (77A)	Brush Lake (26A)	Cuba* (1978) (29A)	East* Lake (15A)	Hanson* Lake (94A)	Ketchum* (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Black-throated green warbler	B*		B	B*			B				B	x
Blackburnian warbler	B	B	B	B*			B				B	x
Chestnut-sided warbler	B	B*	B	B	B	B	B	B1*	B*	B	B	x
Bay-breasted warbler												x
Pine warbler	B	B	B	B					B			x
Palm warbler	*			M		*	*	M				
Ovenbird	B*	B*	B1	B*	B	*	B*	B*	B*	B	B	x
Northern waterthrush	B			B1		B1	B1			B1		
Yellowthroat	B*	B1*	B1	B1*	B	B*	B*	B1*	B1*	B1	B1	x
Mourning warbler			B	B*	B	B	B*	B1	B		B	
Connecticut warbler									B		B	x
Wilson's warbler	*	M	M								M	x
Canada warbler	B								M			x
American redstart	B*	B	B	B1	B		B*	B	B	B	B	x
Golden-winged warbler			B	B				B1	B	B	B	x
Yellow warbler	B*	B*	B1	B	B	*	B*	B1	B1	B1	B1	x
Blackbirds and orioles												
Bobolink				M				M	M			
Yellow-headed blackbird	*											
Red-winged blackbird	B1*	B1*	B1	B1*	B1	B1*	B1*	B1*	B1*	B1	B1	x
Brewer's blackbird												x
Common grackle	B*	B*	B1	B*	B	B*	B*	B1*	B1*	B	B1	x
Brown-headed cowbird	B	B	B	B1	B	B*	B	B*	B	B		x
Northern oriole	B*	B*	B	B*	B	B1*	B*	B1*	B*	B	B	x
Tanagers												
Scarlet tanager	*	B	B	B	B	B	*	B	B	B	B	x
Grosbeaks, finches, sparrows and buntings												
Rose-breasted grosbeak	B*	B*	B	B*	B	B*	B*	B1*	B*	B	B	x
Evening grosbeak				R				R*	R		R	x
Indigo bunting	B*	B*	B*									
Purple finch			B	B*	B	B		B	B		B	x
Pine grosbeak			W									x
Common redpoll						W	W					x
Hoary redpoll						W						
Pine siskin												x
American goldfinch	B	B	B	B	B1	B1*		B	B	B	B	x
White-winged crossbill												x
Red crossbill								W				
Rufous-sided towhee												x
Savannah sparrow												x
LeConte's sparrow			M	M								x
Vesper sparrow												x
Dark-eyed junco				M	M			M				x
Tree sparrow												x
Chipping sparrow	B*	B	B				B	B	B	B	B	x
Clay-colored sparrow												x
White-throated sparrow	B*	B		B*		*	B	B	B	B	B	x
Fox sparrow	*			M								x
Swamp sparrow	B	B1	B1	B1	B	B1		B1	B1	B1	B1	x
Song sparrow	B1*	B1*	B1	B1*	B1	B1*	B1*	B1*	B1*	B1	B1	x
Snow bunting												x
	77	80	94	106	83	60	67	98	100	79	96	

Note: R— Resident year-round
B— Breeds–does not winter
M— Migrant
W— Winter visitor
S— Summer visitor (non-breeding)

*–Mathisen Study (1974)

R1, b1–Nest located within 33 m of impoundment or nesting inferred by other means.

REPTILES & AMPHIBIANS 1978 & 1979

Species	Amik (1979) (108A)	Ball Club (49A)	Bear Brook (58A)	Beaver Lodge (77A)	Brush Lake (26A)	Cuba (1978) (29A)	East Lake (94A)	Hanson Lake (94A)	Ketchum (51A)	Six Mile (24A)	Sucker Bay (41A)	Kirby Study (1973)
Snapping turtle *Chelydra serpentina*		V						V		V		V
W. painted turtle *Chrysemys picta belli*	V	V	V	V	V		V	V	V	V		V
N. red-bellied snake *Storeria occipitomaculata*				V				V				V
E. garter snake *Thamnophis sirtalis s.*		V	V	V	V		V	V	V		V	V
Blue-spotted salamander *Ambystoma laterale*				V								
E. tiger salamander *Ambystoma tigrinum t.*									V			V
American toad *Bufo americanus*	C			V	V			V	V	V		V
N. spring peeper *Hyla crucifer*	C						C		C		C	V
E. gray tree frog *Hyla versicolor*								V			V	V
Chorus frog *Pseudacris triseriata*								C	C			V
N. leopard frog *Rana pipiens p.*	V	V	V					V	V		V	V
Mink frog *Rana septentrionalis*	C			C				C				V
Green frog *Rana clamitans*				V				V		V		
Wood frog *Rana sylvatica*				V			V	V				
	5	3	4	8	3		4	11	7	4	4	

APPENDIX II: HABITATS OF IMPOUNDMENT VERTEBRATES
MAMMALS 1978 & 1979

Species	Water	Emergents	Deciduous forest	Mixed forest	Dead timber	Wetland shrubs	Openings: Aerial	Openings: Herbs (ground)	Openings: All impound.	Kirby Study (1973)
Masked shrew *Sorex cinereus*		V[1]		V[1]	V[1]	V[1]			x	
Arctic shrew *Sorex arcticus*								V[1]	x	
N. water shrew *Sorex palustris*	V							V[1]	x	V[1]
Pygmy shrew *Microsorex hoyi*		V[1]								V
Short-tailed shrew *Blarina brevicauda*		V[1]		V[1]	V[1]			V[1]	x	V[1]
Starnose mole *Condylura cristata*										V[1]
Little brown myotis *Myotis lucifugus*										V[1]
Big brown bat *Eptesicus fuscus*					V		V		x	V
Black bear *Ursus americanus*			V	V		V		V	x	V
Raccoon *Procyon lotor*	V	V	V					S	x	V
Fisher *Martes pennanti*			V					S	x	
Short-tailed weasel *Mustela erminea*								S		V
Least weasel *Mustela rixosa*										V[1]
Long-tailed weasel *Mustela frenata*								V		V
Mink *Mustela vison*	V							S	x	V
River otter *Latra canadensis*	V	V						S	x	V
Striped skunk *Mephitis mephitis*								S	x	V
Coyote *Canis lutra*								S	x	V
Gray wolf *Canis lupus*								S	x	C
Red fox *Vulpes fulva*								S	x	V
Lynx *Lynx canadensis*										V
Bobcat *Lynx rufus*								S	x	S
Woodchuck *Marmota monax*				V				V	x	V
13-lined ground squirrel *Spermophilus tridecemlineatus*								V	x	V
Franklin's ground squirrel *Spermophilus franklini*								V	x	
Eastern chipmunk *Tamias striatus*			V	V[1]	V[1]			V	x	V
Red squirrel *Tamiasciurus hudsonicus*				V	V			V	x	V
N. flying squirrel *Glaucomys sabrinus*				V[1]					x	V[1],S
Plains pocket gopher *Geomys bursarius*										S
Beaver *Castor canadensis*	V	V				V		S	x	V
Deer mouse *Peromyscus maniculatus*				V[1]	V[1]	V[1]		S	x	V[1]

(table continued on next page)

(table continued)

Species	Water	Emergents	Deciduous forest	Mixed forest	Dead timber	Wetland shrubs	Openings			Kirby Study (1973)
							Aerial	Herbs (ground)	All impound.	
White-footed mouse *Peromyscus leucopus*				V[1]	V[1]	V[1]		V[1]	x	V
Southern bog lemming *Synaptomys cooperi*										V[1]
Boreal red-backed vole *Clethrionomys gapperi*				V[1]	V[1]				x	V[1]
Meadow vole *Microtus pennsylvanicus*		V			V[1]	V[1]		V[1]	x	V[1]
Muskrat *Ondatra zibethica*	V	V							x	V
Gray squirrel *Sciurus carolinensis*			V							
Meadow jumping mouse *Zapus hudsonius*		V[1]		V[1]	V[1]		V[1]	V[1]	x	V[1]
Woodland jumping mouse *Napaeozapus insignis*						V[1]			x	V
Porcupine *Erethizon dorsatum*			V	V					x	V
Snowshoe hare *Lepus americanus*				V			V		x	V
Eastern cottontail *Sylvilagus floridanus*							V			x
Moose *Alces alces*	VV	VV		VV	VV		S			x
White-tailed deer *Odocoileus virginianus*	V	V	VV	V	V			V S	x	V

Note: Code (Kirby's notation)
V = visual observation of the animal
V[1] = a specimen was captured or found dead
S = no visual observation, but tracks or scat found
C = no visual observation, but call noted
in cases where there is a double symbol, the second symbol refers to observation of young and/or nest.

BIRDS

Species	Water				Emergents				Deciduous forest				Mixed forest				Dead timber				Wetland shrubs				Aerial				Ground			
	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W
Loons																																
Common loon	3	2	3		4	4																										
Grebes																																
Pied-billed grebe	3	2	3		3	2	3																									
Herons and allies																																
Great blue heron	2	1	2		4	4	4										4	4	4													
Green heron																		4														
American bittern						2																										
Great egret					4																											
Waterfowl																																
Canada goose																											3					
Mallard	1	1	1		1	1	1										1	1	1		3	3	3									
Black duck		4																														
Pintail			4																													
Gadwall			3																				3									
American wigeon	2	3	2		2	3	2												4		4	4	4									
Blue-winged teal	1	1	1		1	1	1										3	3	3		3	3	3									
Green-winged teal	3	3	3		3	3	3														3	3	2									
Wood duck	1	1	1		2	2	2										1	1	1		1	1	1									
Ring-necked duck	2	1	2		3	2	3														3	3	3									
Common goldeneye	2	2	2		3	3	3										3	2	2													
Bufflehead	4																															
Hooded merganser	2	1	2		3	3	3										2	2	2		3	3	3									
Vultures, hawks, falcons																																
Turkey vulture																										2	2					
Goshawk													4	4	4	4																
Cooper's hawk														4												4						
Sharp-shinned hawk										3	3															3	3					
Marsh hawk																										4	3					
Red-tailed hawk										3	3			2	2			4							2	2	2					
Broad-winged hawk										3	3				4									2	3							
Red-shouldered hawk										3								4								3						
Bald eagle																		4	4							3	3					
Osprey	4	4	4																							2	2					
Kestrel																		2	2							2	2					
Gallinaceous birds																																
Ruffed grouse									2	2	2		2	2	2																	
Cranes and allies																																
Virginia rail						4																										
Sora rail					1	1	4																									
American coot			2																													
Shorebirds																																
Semipalmated plover																															4	
Killdeer																										2	2		2	2	2	
American woodcock										3	3			3	3															3	3	
Common snipe																		3	4						2	2	2					

(table continued on next page)

(table continued)

Species	Water				Emergents				Deciduous forest				Mixed forest				Dead timber				Wetland shrubs				Aerial				Ground			
	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W
Shorebirds cont.																																
Solitary sandpiper																													2		2	
Spotted sandpiper																													2	2	2	
Lesser yellowlegs																															3	
Greater yellowlegs																															3	
Pectoral sandpiper																															4	
Least sandpiper																															4	
Terns																																
Black tern					3	3																			2	2						
Common tern	4																								4							
Pigeons and doves																																
Mourning dove																										4						
Cuckoos																																
Black-billed cuckoo									3	3										3	3											
Yellow-billed cuckoo										4																						
Owls																																
Great horned owl									4	4	4		4	4	4																	
Barred owl									2	2	3	3																				
Goatsuckers																																
Common nighthawk																										3						
Swifts																																
Chimney swift																										3						
Hummingbirds																																
Ruby-throated hummingbird									3	3															3	2						
Kingfishers																																
Belted kingfisher																	2	2	3													
Woodpeckers																																
Common flicker										2	2						3	2	2											3	2	
Pileated woodpecker									3	3	3	3						3	3													
Yellow-bellied sapsucker										2	3							2	3													
Hairy woodpecker									2	2	2	2						3	3													
Downy woodpecker									2	2	2							2	2													
Red-headed woodpecker																	4		4						4		4					
Flycatchers																																
Eastern kingbird										3								1				2				3						
Great-crested flycatcher										2								2														
Eastern phoebe														3				3														
Alder flycatcher																				3												
Least flycatcher										1				2				3														
Eastern wood pewee										2								3														
Olive-sided flycatcher																		3														
Swallows																																
Barn swallow																										2						
Cliff swallow																										3						
Rough-winged swallow																									4	4						
Tree swallow																		1								1						
Purple martin																										3						

(table continued on next page)

(table continued)

Species	Water				Emergents				Deciduous forest				Mixed forest				Dead timber				Wetland shrubs				Aerial				Ground			
	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W
Jays and crows																																
Blue jay									2	2	2	2	2	2	2	2	3	3	3	3												
Gray jay													2	4	2	3																
Common crow										2	2		3	3	3											2	2					
Common raven																									2	4	2	2				
Chickadees																																
Black-capped chickadee									1	2	1	1	1	2	1	1																
Nuthatches and creepers																																
White-breasted nuthatch									3	3	3	3						3	3													
Red-breasted nuthatch									3	3	3	3	2	2	2	3																
Brown creeper															3	3	3	3	3													
Wrens																																
Winter wren													3	3																		
Short-billed marsh wren					2	2															3											
Long-billed marsh wren					2	2															4											
House wren										4																						
Mockingbirds and thrashers																																
Catbird										3											2											
Thrushes																																
Robin									2	2	2			4	4			3	3		4	4								3	3	
Wood thrush									4	4																						
Hermit thrush														4	4																	
Swainson's thrush													4		4																	
Veery										2				3																		
Kinglets																																
Ruby-crowned kinglet													3		3																	
Waxwings																																
Cedar waxwing									3	2								2			3					2						
Shrikes																																
Northern shrike																				4												
Loggerhead shrike																		4														
Starling																		3														
Vireos																																
Solitary vireo													4	4	4																	
Red-eyed vireo									2	1	4			3	4																	
Philadelphia vireo										4																						
Warbling vireo										3																						
Yellow-throated vireo										3																						

(table continued on next page)

(table continued)

Species	Water				Emergents				Deciduous forest				Mixed forest				Dead timber				Wetland shrubs				Aerial				Ground			
	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W	S	S	F	W
Warblers																																
Magnolia warbler													4	4																		
Black and white warbler									2	2	4		3	3	4																	
Nashville warbler																					3	3										
Parula warbler										3	4			3	4																	
Cape May warbler									4		4																					
Yellow-rumped warbler									2	3	2		1	3	1					2	4	2										
Black-throated green warbler													3	3	3																	
Blackburnian warbler													3	3																		
Chestnut-sided warbler									2	2	3			3	4					2	2	3										
Pine warbler													4	4	4																	
Palm warbler															2																	
Ovenbird									2	2	2		2	2	2																	
Northern waterthrush										2																						
Yellowthroat																				2	1	2										
Mourning warbler																					3											
Connecticut warbler														4																		
Wilson's warbler																				4												
Canada warbler																				4	4	4										
American redstart									2	2	3									2	2	3										
Golden-winged warbler										4											3											
Yellow warbler										3	3										1	3										
Blackbirds and orioles																																
Bobolink																									4	4						
Yellow-headed blackbird																										4						
Red-winged blackbird					1	1	2										1	1	2		1	1	2									
Common grackle									2	2	2		2	2	2		2	2	2		2	2	2									
Brown-headed cowbird									2	2	3		3	3	3		2	2	3													
Northern oriole									4	2	4			4				2				3										
Tanagers																																
Scarlet tanager										2	4			4																		
Grosbeaks, finches, sparrows and buntings																																
Rose-breasted grosbeak										1				3																		
Evening grosbeak										3				3	2																	
Indigo bunting										3								4	4													
Purple finch										3				3				3														
Pine grosbeak																4																
Common redpoll																																4
Hoary redpoll																																4
American goldfinch										4								2												3		
Red crossbill																4																
LeConte's sparrow																					4											
Dark-eyed junco																													1		1	
Chipping sparrow									4	4			4	4																		
White-throated sparrow																				2	3											
Fox sparrow																															4	
Swamp sparrow					3															2											
Song sparrow																		3														

Note: Sp–Mar 16-Jun 5
Sm–Jun 6-Aug 30
F–Sep 1-Nov 30
W–Dec 1-Mar 15

ABUNDANCE: 1–Abundant >5/day
2–Common 1-5/day
3–Regular 5 sightings/year
4–Occasional >1-5 sightings/year

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Probst, John R.; Rakstad, Donald; Brosdahl, Kathy.
Diversity of vertebrates in wildlife water-impoundments on the Chippewa National Forest. Res. Pap. NC-235. St. Paul, MN: U.S. Department of Agriculture, Forest Service, North Central Forest Experiment Station; 1983. 22 p.

Gives an annotated list of mammals, birds, reptiles and amphibians in 1978 and 1979 in forested wetlands of northern Minnesota. Describes habitat preferences of vertebrates, relative abundance of bird species, and general management recommendations for wildlife.

KEY WORDS: Mammals, birds, reptiles, amphibians, habitat preferences, relative abundance, species distributions, wetland management.